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OPTICAL REPEATER MONITORING DEVICE

【Claims】

【Claim 1】 An optical repeater monitoring device included in an optical repeater which comprises: a rare-earth element doped fiber amplifying a signal light from upstream with an injection of an excitation light, and outputting the amplified signal light to downstream; a two-input, two-output wavelength multiplexing coupler of which one input end and one output end are connected downstream the rare-earth element doped fiber; an excitation light source connected to the other input end of the wavelength multiplexing coupler, which outputs the excitation light; and an optical transmitter connected to the other output end of the wavelength multiplexing coupler, which outputs a wavelength light having a wavelength between an excitation light wavelength and a signal light wavelength,

wherein the optical transmitter transmits the wavelength light downstream through the wavelength multiplexing coupler on the occurrence of a failure in the optical repeater.

【Claim 2】 An optical repeater monitoring device included in an optical repeater which comprises: a rare-earth element doped fiber amplifying a signal light from upstream with an injection of an excitation light, and outputting the amplified signal light to downstream; a first two-input, two-output wavelength multiplexing coupler of which one input end and one output end

are connected downstream the rare-earth element doped fiber; a second two-input, two-output wavelength multiplexing coupler of which one input end and one output end are connected upstream the rare-earth element doped fiber; excitation light sources respectively connected to the other input end of the first wavelength multiplexing coupler and the other input end of the second wavelength multiplexing coupler, which output the excitation light; an optical transmitter connected to the other output end of the first wavelength multiplexing coupler, which outputs a wavelength light having a wavelength between an excitation light wavelength and a signal light wavelength; and an optical receiver connected to the other output end of the second wavelength multiplexing coupler, which receives the wavelength light from upstream,

wherein the optical transmitter transmits the wavelength light downstream through the wavelength multiplexing coupler on the occurrence of a failure in the optical repeater.

【Claim 3】 The optical repeater monitoring device according to claim 2, wherein the signal light includes a superposed low frequency signal, and the optical receiver detects the signal light by extracting the low frequency signal.

【Claim 4】 The optical repeater monitoring device according to claim 4, further comprising a photodetector downstream the first wavelength multiplexing coupler according to claim 1, wherein the photodetector detects the signal light by extracting the low frequency signal.

【Claim 5】 The optical repeater monitoring device according to

claim 2, wherein the optical receiver includes an optical filter intercepting the excitation light wavelength.

【Detailed description of the invention】

【0001】

【Application field in industry】 The present invention relates to an optical repeater employing an optical amplifier, and more particularly an optical repeater monitoring device transmitting failure information in the event of a failure.

【0002】

【Prior art】 An optical amplifier employing an optical fiber in which a rare earth element such as Erbium is included may be applicable to an optical repeater, because of a high gain and a large saturation output of the optical amplifier. When such an optical amplifier is employed as optical repeater, a monitoring method for the optical repeater becomes a key issue. Hereafter, a system having a plurality of optical repeaters connected onto an optical fiber will be discussed.

【0003】 As minimally required monitoring function, a function of notifying occurrence of a failure in an optical repeater to downstream devices is necessary. To actualize this function, a configuration shown in FIG. 3 may be considered. In this figure, symbols 1, 2 denote excitation light sources, by which an excitation light is input to an Erbium doped optical fiber 5 through wavelength multiplexing couplers 3, 4. Symbols 6, 7 denote optical isolators, which are inserted to suppress occurrence of oscillation. The function of the optical amplifier is achieved with the above-mentioned configuration. In addition,

an LD 8 for transmission and an optical coupler 9 are required for information notification in the event of a failure. Also, an optical coupler 10 and a photodetector 11 are required for receiving the failure information transmitted from upstream. More specifically, in the event of a failure in the optical repeater of interest, an optical signal having the failure information is output from LD 8, and transmitted via optical coupler 9 to an optical repeater provided in another station connected downstream. Also, when an optical signal having failure occurrence information is transmitted from another optical repeater connected upstream, the optical signal is received in photodetector 11 via optical coupler 10.

【0004】 Here, in such a configuration, the light output from the optical repeater is decreased in optical coupler 9 even in a normal condition. On the input side also, the signal light is decreased caused by optical coupler 10. Therefore, both the gain characteristic and the saturation output characteristic are virtually deteriorated. One method to solve such a problem is to employ an optical switch in place of optical coupler 9. FIG. 4 shows a diagram illustrating an optical repeater configuration incorporating an optical switch 12. In this configuration, optical switch 12 is normally connected to an optical isolator 7, and a signal light is transmitted downstream as it is. In the event of a failure, optical switch 12 is connected to LD 8, so that the optical signal indicating the failure is transmitted downstream. However, since the optical switch is higher in cost than the optical coupler, and also an insertion

loss produced at the time of switchover is larger, this method is not effective to solve the problem.

【0005】

【Problems to be solved by the invention】 As described above, when adding a monitoring function to the optical amplifier, the gain characteristic and the saturation output characteristic are deteriorated, producing reduction of a capacity required for the optical amplifier. Accordingly, it is an object of the present invention to add a monitoring function to the optical repeater without reducing the capacity of the optical repeater.

【0006】

【Means to solve the problems】 The present invention relates to an optical repeater monitoring device included in an optical repeater. The optical repeater includes: a rare-earth element doped fiber amplifying a signal light from upstream with an injection of an excitation light and outputting the amplified signal light to downstream; a first two-input, two-output wavelength multiplexing coupler of which one input end and one output end are connected downstream the rare-earth element doped fiber; a second two-input, two-output wavelength multiplexing coupler of which one input end and one output end are connected upstream the rare-earth element doped fiber; excitation light sources respectively connected to the other input end of the first wavelength multiplexing coupler and the other input end of the second wavelength multiplexing coupler, which output the excitation light; an optical transmitter connected to the other output end of the first wavelength multiplexing coupler, which

outputs a wavelength light having a wavelength between an excitation light wavelength and a signal light wavelength; and an optical receiver connected to the other output end of the second wavelength multiplexing coupler, which receives the wavelength light from upstream. The above optical transmitter transmits the wavelength light downstream through the wavelength multiplexing coupler on the occurrence of a failure in the optical repeater.

【0007】

【Functions】 According to the present invention, because the optical signal wavelength transmitted on the occurrence of a failure is set between the signal light wavelength and the excitation light wavelength, the wavelength multiplexing coupler can perform branching of the light with accuracy. Namely, since the wavelength multiplexing coupler multiplexes and branches the wavelength of the excitation light and the signal light, in an intermediate region of these wavelengths, there arises an intermediate optical coupling condition of neither 0 nor 1. Accordingly, by connecting an optical transmitter transmitting a signal with this intermediate wavelength to a wavelength multiplexing coupler installed downstream (on the rear side), this optical signal can be transmitted. Also, by connecting an optical receiver to a wavelength multiplexing coupler installed upstream (on the front side), an optical signal of this wavelength transmitted from upstream can be received.

【0008】 In the amplifier, doped with Erbium as rare earth element, a wavelength of 1.48 μm may be used as excitation light wavelength,

and a wavelength of 1.55 μm may be used as signal light. In this case, when a wavelength of 1.53 μm is used for transmitting the failure information, optical coupling on the order of 20% can be expected in the wavelength multiplexing coupler, and conveniently, the wavelength light of 1.53 μm corresponds to another gain peak in the optical amplifier.

【0009】

【Embodiments】 The embodiments of the present invention will be described hereafter.

【0010】 FIG. 1 is an exemplary embodiment of an optical repeater monitoring device in accordance with the present invention. Like symbols refer to like parts shown in FIG. 3. Symbols 1, 2 denote excitation light sources, of which excitation light is led to an Erbium doped optical fiber 5 through wavelength multiplexing couplers denoted by symbols 3, 4. Further, symbols 6, 7 denote optical isolators provided for suppressing an oscillation. The above portions of symbols 1 - 7 constitute an optical amplifier.

【0011】 Here, it is assumed that a wavelength of each light source 1, 2 is 1.48 μm, a wavelength of the signal light is 1.55 μm, and that a semiconductor laser 21 is used for transmitting information on the occurrence of a failure, of which wavelength is set to 1.53 μm. Using wavelength multiplexing couplers 3, 4 constituted of fused optical fiber type, approximately 20% of the output light from semiconductor laser 21 can be coupled onto an output fiber 23. Further, the Erbium doped optical fiber amplifier has one gain peak in a wavelength region of 1.530 μm - 1.536 μm, and another gain peak in a wavelength region of 1.55

μm - 1.56 μm. Therefore, as to a light having wavelength 1.53 μm, high gain can be expected in the optical amplifier. If the failure information is transmitted downstream using this wavelength, the information can be transmitted while the information is amplified in each optical amplifier.

【0012】 The failure information transmitted from upstream can be received in a photodetector 22. Since the wavelength of the failure information is 1.53 μm, 80% of optical power is amplified by the optical fiber amplifier in wavelength multiplexing coupler 3 via isolator 6, and led to output fiber 23. Also 20% of the optical power is led to photodetector 22, enabling detection of the upstream failure.

【0013】 Although not shown in the figure, by implementing a monitor circuit by use of a microcomputer, etc., temperature and output power of excitation light sources 1, 2, and information of photodetector 22 are taken in. Further, it may also be possible for the monitoring circuit to perform operation such as forwarding the failure information to downstream by driving semiconductor laser 21.

【0014】 FIG. 2 is another embodiment of the present invention. In this figure, like symbols are referred to like parts shown in FIG. 1. This embodiment is configured so as to enable detection of an input signal break, as well as an output signal break. A signal light is intensity modulated with frequency f and modulation factor of a few percent, by a light having a wavelength of 1.55 μm. This signal can be acquired by direct modulation of the transmission semiconductor laser. By setting more than

a few KHz as f, it is also possible to suppress stimulated Brillouin scattering on the transmission line fiber. In the embodiment shown in FIG. 2, an optical fiber 25 is inserted at one end of wavelength multiplexing coupler 3, so that the excitation light of 1.48 μm is intercepted here. A wavelength of 1.55 μm leaked from wavelength multiplexing coupler 3 is converted into an electric signal by photodetector 22, and a signal 27 having a frequency f is extracted by a bandpass filter 26. With such a configuration, extremely high-sensitive light detection is possible, to the extent that the light detection of 1.55 μm can be performed from 1 - 2% crosstalk light leaked from wavelength multiplexing coupler 3. Also, the failure information of wavelength 1.53 μm can be extracted through 28. As to detection of output break is performed by detecting a leak light from optical isolator 7, etc. by a photodetector 29, and a signal of frequency f is extracted by a bandpass filter 30. Or, differently, by connecting an optical coupler to output fiber 23, a portion of the output light is extracted and input to photodetector 29.

【0015】 In such a system described above, in which an input break is detected and occurrence of a failure is transferred to downstream using semiconductor laser 21, the entire optical repeaters installed downstream the optical fiber break point may undesirably issue the information of failure occurrence, though the optical fiber has been broken at only one point. However, since the signal from upstream can be received by photodetector 22 even when semiconductor laser 21 is in operation,

the above problem may be solved if the monitoring circuit is operated so as to stop further forwarding of the failure occurrence signal immediately on receipt of the failure occurrence signal from upstream.

【0016】

【Effects of the invention】 As the embodiments of the present invention having been described, the optical repeater monitoring device can transmit and receive a failure signal without using an optical coupler. Accordingly, the following effects may be achieved: The optical repeater gain and output are not reduced. The present invention is suitable for producing a small-sized and highly reliable device, because of a small number of components required.

【Brief description of the drawings】

【FIG. 1】 shows a diagram illustrating one embodiment of an optical repeater monitoring device.

【FIG. 2】 shows a diagram illustrating another embodiment of an optical repeater monitoring device.

【FIG. 3】 shows a diagram illustrating an optical repeater monitoring device easily analogized from the prior art.

【FIG. 4】 shows a diagram illustrating an optical repeater monitoring device having a switching function, which is easily analogized from the prior art.